

# NASA Earth Science Portfolio

#### David B. Jarrett

Program Executive, Earth Science Division National Aeronautics and Space Administration

Landsat Science Team Meeting July 7, 2015

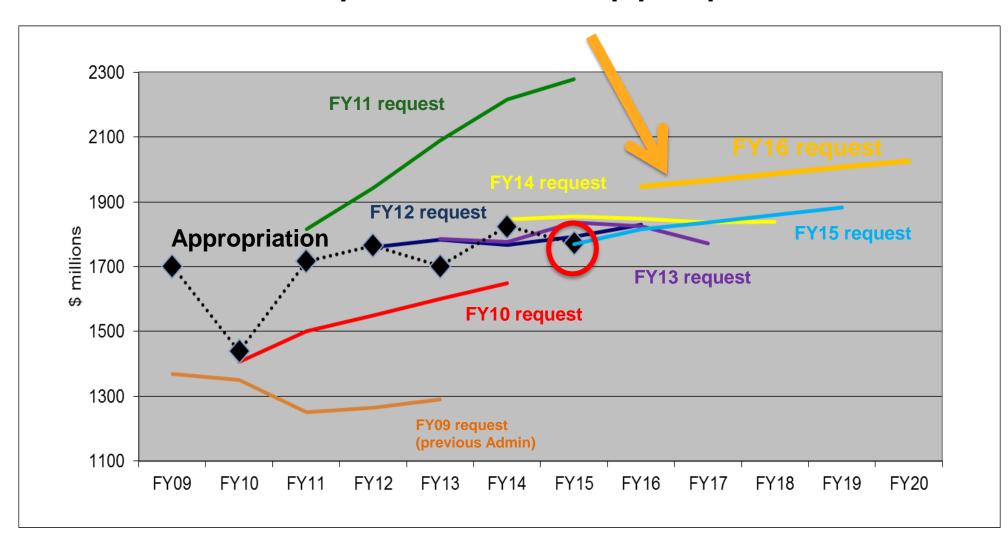
### Earth Science Overview

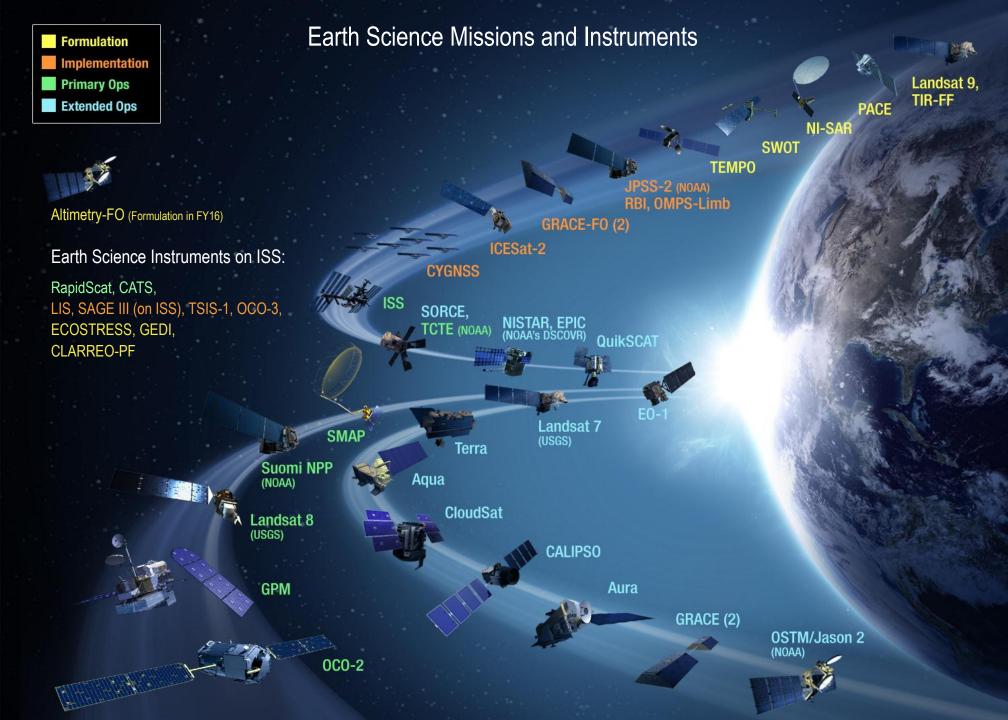
- Strategic Objective: To advance knowledge of the Earth as a system to meet the challenges of environmental change and to improve life on our planet.
  - Collecting the data to provide accurate information to inform decision making
  - Emphasize acquisition of data; analyses that combine multiple data sets; and development of efficient information products that yield societal benefit

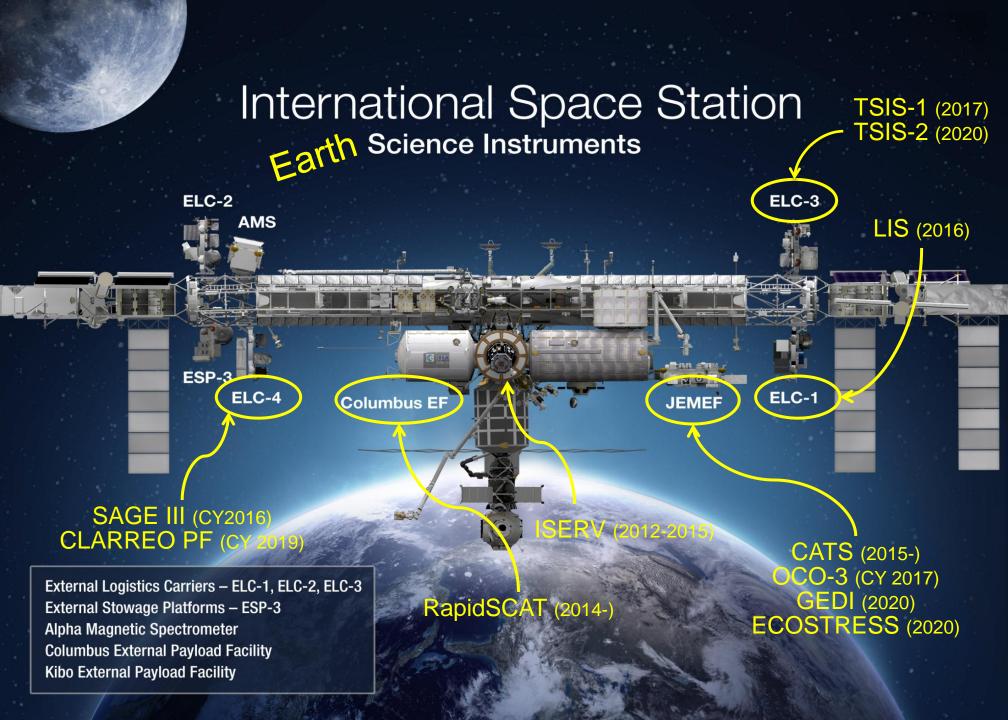
#### Major activities:

- Building and operating Earth observing satellite missions, many with international and interagency partners
  - Successfully orbited 3 new Earth Observing missions (GPM, OCO-2 and SMAP) and 2 new ISS instruments (RapidScat and CATS) within 11 months (February 2014 – January 2015)
  - NASA is presently *operating 19 on-orbit research missions*: Landsat 7 (w/USGS), QuikSCAT, Terra, EO-1, Jason 2, GRACE, Aqua, SORCE, Aura, Cloudsat, CALIPSO, Suomi-NPP (w/NOAA), Landsat 8 (LDCM, w/USGS) and TCTE, and the 5 new additions
  - NASA now has responsibility for all civil earth observations for the nation except satellite missions that contribute directly to NOAA's ability to issue weather and space weather forecasts and warnings
    - Sustainable Land Imaging Program (w/USGS; NASA funds flight hardware)
    - Long-term measurement of Altimetry, Solar Irradiance, Ozone Profile, Earth Radiation Budget
- Making high-quality data products available to the broad science community
- Conducting and sponsoring cutting-edge research
  - o *Field campaigns* to complement satellite measurements
  - Analyses of NASA and non-NASA mission data
  - Modeling
- Applied Science to develop and demonstrate applications delivering societal benefit, and building user capacity
- Developing technologies to improve Earth Science observation and information systems capabilities

# Earth Science Budget: FY16 Request/FY15 Appropriation



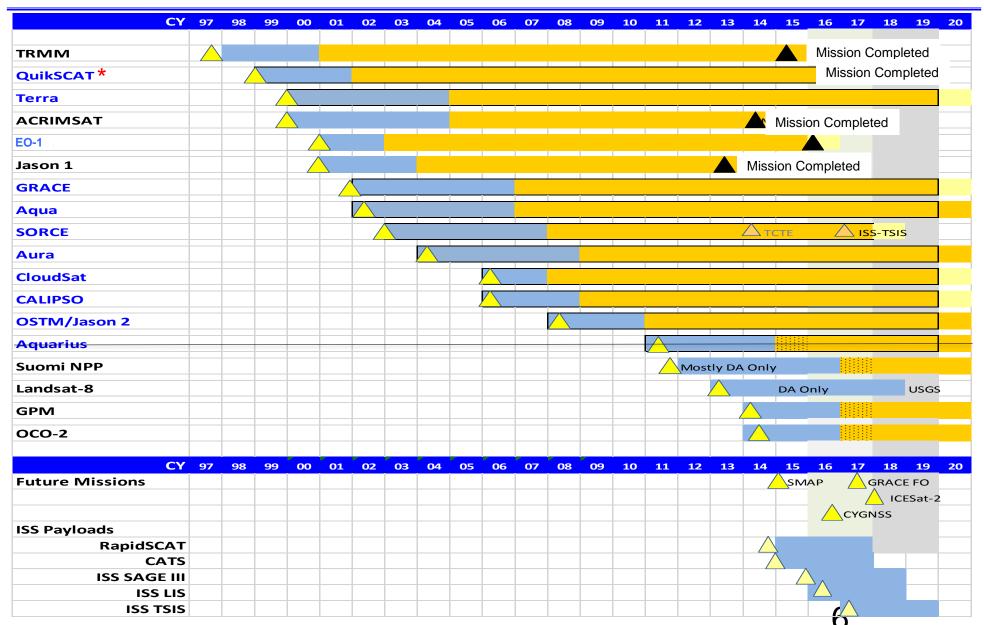






#### **ESD 2015 Senior Review Mission Set**

Prime
Extension
Phase F



# Venture Class Selections/Solicitations

Mission	Mission Type	Solicitation Release	Proposal Selection	Major Milestone	Total Funding*
EVI-3	Instrument Only	Q2 FY2015	Q2 FY2016	Delivery NLT 2020	\$130M
EVI-4	Instrument Only	Q4 FY2016	Q4 FY2017	Delivery NLT 2021	\$150M
EVI-5	Instrument Only	Q2 FY2018	Q2 FY2019	Delivery NLT 2023	\$182M
EVI-6	Instrument Only	Q4 FY2019	Q4 FY2020	Delivery NLT 2024	\$155M
EVI-7	Instrument Only	Q2 FY2021	Q2 FY2022	Delivery NLT 2025	\$185M
EVM-2	Full Orbital	Q3 FY2015	Q3 FY2016	Launch ~2021	\$165M
EVM-3	Full Orbital	Q3 FY2019	Q3 FY2020	Launch ~2025	\$179M
EVS-2	Suborbital	Q4 FY2013	Q1 FY2015	2016-2020	\$162M
EVS-3	Suborbital	Q4 FY2017	Q4 FY2018	2019-2023	\$176M

Most recent Selection

EVS-1: CARVE, ATTREX, DISCOVER-AQ, AirMOSS, HS-3

**EVM-1: CYGNSS (2016 LRD)** 

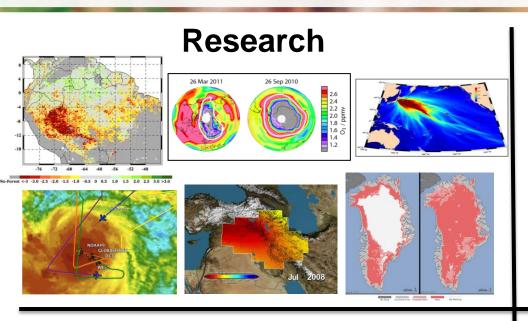
EVI-1: TEMPO (2017 Instrument Delivery)

EVI-2: GEDI, ECOSTRESS (2019 Inst. Del.)

EVS-2: AtoM, NAAMS, OMG, ORACLES, ACT-America

<sup>\*</sup> Funding for future EVs is approximate and will be adapted depending on previous selections.

## NASA's Earth Science Division

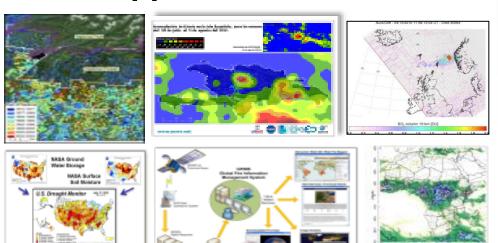


#### **Flight**





#### **Applied Sciences**



# **Technology**





# **Sustainable Land Imaging**



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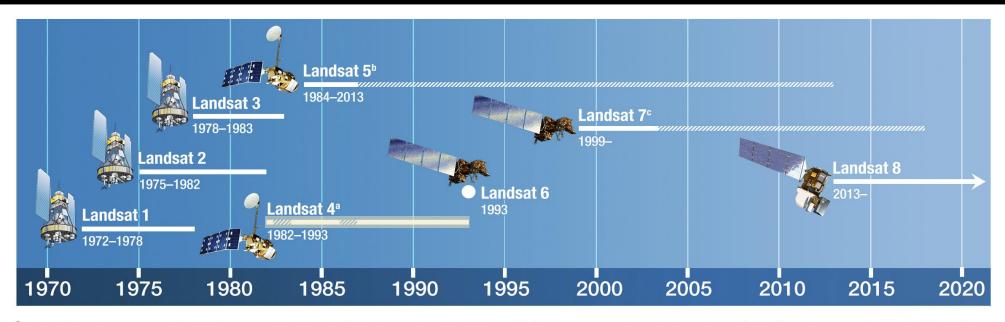


Chesapeake Bay Landsat 8 surface reflectance mosaic, 2014

"Surface reflectance" is a new USGS Landsat product that corrects for the effects of haze, aerosol, water vapor, and ozone on Landsat data. This processing provides a sharper view of the Earth's surface, as if there were no atmosphere interrupting the view between the satellite and ground.

## Landsat History





<sup>a</sup>Limited data due to transmitter failure soon after launch. Only 45,172 Landsat 4 Thematic Mapper scenes from 1982–1993 available for science users—~10 scenes/day (vs 725 scenes/day from L8)

<sup>b</sup>Data coverage limited to Continental US (CONUS) and International Ground Station sites after a transmitter failure in 1987; Multispectral Scanner turned off in August 1995 <sup>c</sup>Degraded Performance due to Scan Line Corrector failure in May 2003

- The Landsat program began as the Earth Resources Technology Satellites Program in 1966, with Landsat 1 (ERTS) launched in July 1972
- NASA built and launched Landsats 1-5 and Landsats 7-8
- Thermal band added for Landsats 3 and beyond
- After launch, Landsat operations are transferred from NASA to USGS, and USGS collects, archives, processes, and distributes
  the image data via the internet at no cost to users
- Landsat 8 began as a data purchase and became known as the Landsat Data Continuity Mission (LDCM)
  - Although the thermal bands were originally not incorporated in the mission, they were added back into the Observatory's capabilities following strong support from a variety of stakeholders

# SLI in FY16 President's Budget Submission



→ A multi-component program, with the essential investments in technology and observational innovation to ensure a world class, sustainable, and responsible land imaging program through 2035:

# SLI in FY16 President's Budget Submission

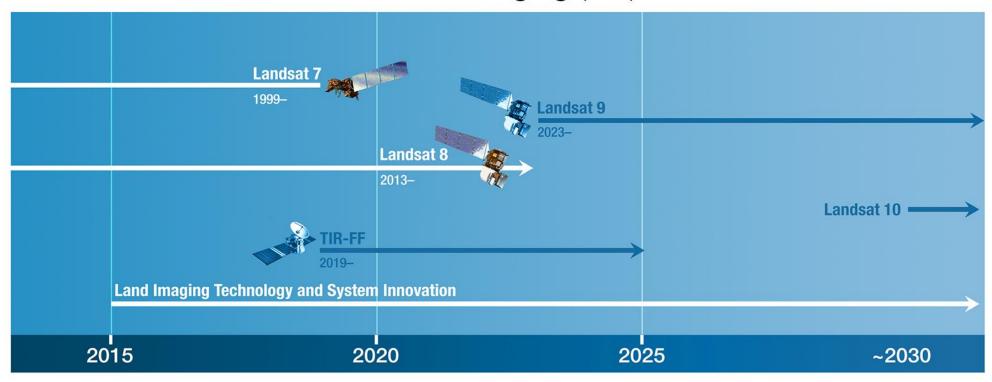


- A multi-component program, with the essential investments in technology and observational innovation to ensure a world class, sustainable, and responsible land imaging program through 2035:
  - 1. TIR-FF (Class D Thermal Infrared Free Flyer) to launch ASAP (no later than 2019) and to fly in constellation with a reflective band imager like OLI on L-8
    - Low-cost mitigation against an early loss of the Landsat 8 Class C TIRS, while demonstrating feasibility of constellation flying for land imaging
  - 2. Landsat 9 (Class B upgraded rebuild of Landsat 8) to launch in 2023
    - Low programmatic risk implementation of a proven system with upgrades to bring the whole system to Class B
  - 3. Land Imaging Technology and Systems Innovation
    - Hardware, operations and data management/processing investments to reduce risk in next generation missions
  - 4. Landsat 10
    - Mission definition to be informed by the Technology investments, leading to key mission configuration/architecture decisions by the end of the decade

## Landsat Future



#### Sustainable Land Imaging (SLI) Architecture







# Landsat 9

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#### Landsat 9 Project Manager Del Jenstrom says:

- Landsat 9 is Underway!!
- Strong support from Administration, Congress, NASA, and USGS
- Strong support from Landsat Science Team and users around the world
- Strong team is being assembled by both NASA and USGS
  - Great mix of Landsat veterans and talented new blood
- Strong relationship between NASA and USGS continuing directly from Landsat 8 launched 2 years ago
- Landsat 9 builds on great performance of Landsat 8

It's as good as it gets!!







#### **Landsat 9 Authorization**

Letter from SMD/Earth Science Division to GSFC, dated March 4, 2015

- Establish Landsat 9 Project office at GSFC
- Evaluate ability to streamline formulation
  - Top-level Project documentation signed by September 30, 2015
  - Mission Definition Review and KDP-B targeted for Spring 2016
- Plan for 5 years of mission ops & data analysis post launch
- Launch no later than 2023
  - Near-term work does not preclude an earlier LRD likely 2021
- Measurement capabilities consistent with L8 Level 1 requirements
- Design & implementation capitalizes on existing L8 assets
- Category 1, Risk Class B project both instruments & s/c
- NASA & USGS responsibilities ~same as on L8







# **Nominal Development Plan**

#### Acquisition Plan

- Instruments
  - Build TIRS-2 in-house at GSFC
  - Sole source OLI-2 to BATC
- Compete spacecraft w/ observatory I&T
- Compete launch vehicle in coordination with NASA/LSP
- USGS develops MOC and data processing/archiving system

#### Development Plan

- Begin instrument work immediately
- Begin spacecraft and LV work as soon as possible/necessary
  - Near-term work does not preclude earlier LRD
- USGS begins ground system work immediately

